Appendix E

Statistical Results for Chemical Analytical Data from Material Disposal Area H

APPENDIX E STATISTICAL RESULTS FOR CHEMICAL ANALYTICAL DATA FROM MATERIAL DISPOSAL AREA H

E-1.0 INTRODUCTION

This appendix provides detailed statistical evaluations that support Section 2.3.4 (data review); Section 3.1 (nature and extent); and Section 4.0 (site assessments). To support the data review and nature and extent sections, the statistical analyses include summary statistics, exploratory data analyses, and background comparisons. Statistical methods are described below. The plots and evaluation results are presented in Section E-3.0. Separate sections are presented for media, which include channel sediments and subsurface tuff. Constituents include inorganic chemicals (metals and cyanide), radionuclides, and organic chemicals (volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], polychlorinated biphenyls [PCBs], and pesticides).

E-2.0 OVERVIEW OF STATISTICAL METHODS

A variety of statistical methods may be applied to each of the data sets. The use of any of these methods depends on how appropriate the method is for the available data.

E-2.1 Summary Statistics

Summary statistics are calculated and presented in tables. For values reported as detected, summary statistics include minimum and maximum reported concentrations to provide the range of the data. The median and arithmetic average concentrations are also provided to give some indication of the central tendency and skew of the concentration distribution. For data sets containing values reported as nondetects, the summary table includes the minimum and maximum reported detection limits (DLs) or estimated quantitation limits (EQLs).

E-2.2 Exploratory Data Analyses

Graphical analyses include box plots and borehole profile plots. These analyses provide a visual representation of the data and determine the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison among concentration distributions. The differences of interest may include an overall shift in concentration (shift of central location) or, when the centers are nearly equal, a difference between the upper tails of the two distributions (elevated concentrations in a small fraction of one distribution). The plots may be used in conjunction with the statistical tests (distributional comparisons) described below. Unless otherwise noted, the nondetects are included in plots at their reported DL or EQL.

Box Plots. A box plot consists of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25th percentile and the 75th percentile of the data, the interquartile range or middle half of the data. The horizontal line within the box represents the median (50th percentile) of the data. The whiskers give an interval of 1.5 times the interquartile range, outside of which data may be evaluated for their potential to be outliers. When box plots are presented from more than two groups, the box representing the baseline or background set is the leftmost box, and the remaining boxes, unless otherwise noted, are arranged in ascending order by group medians. Often, the concentrations are plotted as points overlaying the box plot. When a data set contains both detected concentrations and nondetected results reported as DLs, the detected concentrations are plotted as x's, and the nondetected results are plotted as o's.

Borehole Profile Plots. Borehole profile plots depict the concentration results by depth in boreholes. They are used to evaluate evidence of release from the disposal structure associated with a given borehole and to determine if the extent of any contamination has been bounded (decreasing trend). The filled circles represent detects, the open circles represent nondetects, and the dotted line represents the background value (BV).

E-2.3 Distributional Comparisons

Comparisons between data sets that might represent different concentration distributions, such as site-specific data and Los Alamos National Laboratory (Laboratory) background data, are performed using a variety of statistical methods. For background comparisons, these methods begin with a simple comparison of site-specific data with an upper tolerance limit (UTL) estimated from the background data (UTL [95,95] or the 95% upper confidence bound on the 95th quantile). UTLs are used to represent the upper end of concentration distribution and are also referred to as BVs. UTL comparisons are followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions, e.g., a test of the hypothesis that site concentrations are elevated above background levels. Nonparametric tests that are most commonly performed include the two-sample Wilcoxon Rank Sum test (Wilcoxon test), the Gehan test (modification of the Wilcoxon test), and the quantile test (Gehan 1965, 55611; Gilbert and Simpson 1990, 55612). The Gehan test is best suited for assessing complete shifts in distributions. This test accounts for nondetects at multiple DLs in a statistically robust manner. If there are no nondetects in the data, the Gehan test is equivalent to the Wilcoxon test. The quantile test is better suited for assessing shifts of a subset of the data[1]. Between the two tests (Gehan and quantile), most types of differences between distributions can be identified. Occasionally, if the differences between two distributions appear to occur far into the tails, the slippage test might be performed. This test evaluates the potential for some of the site data to be greater than the maximum BV if, in fact, the site data and background data came from the same distribution. If the data reasonably satisfy normality assumptions, as demonstrated with the exploratory data analysis[2], and there are relatively few nondetects, then a parametric t-test can be used to compare two distributions. Observed significance levels (p-values) are obtained from the Gehan, quantile, slippage, and/or t-tests. If a p-value is much less than a specified probability, e.g., 0.05 (a nominal significance level), then there is some reason to suspect that there is a difference between the distributions. If the p-value is much greater than 0.05, no difference is indicated. If the p-value is close to 0.05, then the need for further evaluation is indicated. In particular, when many tests are performed on the same set of data, there is an increased possibility of observing a p-value of less than 0.05 by random chance alone. Adjustments to the nominal significance level can be considered using methods described in Box et al. (1978, 56653, pp.203–207) and Keppel (1982, 56652, pp. 145-165).

For analytes that are rarely detected in Laboratory background (e.g., mercury, antimony, and thallium in soil samples), an increased detection rate at the site may provide evidence of a release. The chi-square goodness-of-fit test can be used to check for differences in proportions from data sets that fall into given categories. Categorizing proportions from data sets on the basis of two attributes and testing for a difference is also referred to as a test for independence of attributes. For example, this test can be used to test whether the attribute of detection rate (proportion of detected results out of the total analyses

[1] The quantile test is performed at a specified quantile level, usually 80%. This threshold is established to determine if the relative proportion of the two populations being tested is different in the top 20% of the data than it is in the remainder of the data. If this difference is recognized, then there is reason to believe that the distributions are partially shifted because of different tail effects. However, this implies that this test cannot be performed if more than 80% (or the threshold percentage) of the combined data are nondetects.

[2] Formal tests for normality might also be performed, such as the Kolmogorov-Smirnov test (Gilbert 1987, 56179).

performed) is the same in the site data set and the background data set (attribute of membership in the category of site or background data sets). If these proportions are not significantly different, the detection rate attribute is independent of the categorization into background versus site sets (Box et al. 1978, 56653, pp. 145-150; Hollander and Wolfe 1999, 68418, pp. 473-475). This test on detection rates is inappropriate when the two data sets were not analyzed with similar methods or do not have similar DLs. When sample sizes or detection rates at a site are small (e.g., no detects were observed), the rate can be evaluated using binomial probability. Under the assumption that the detection rate (proportion of detects, p) in Laboratory background is the true population rate, the probability of the observed rate at the site can be calculated using a binomial probability as follows. The probability of observing x detects out of n samples given p is the true detection rate and is (n!/x!(n-x)!)p(1-p), where ! is the notation for factorial, e.g., n! = n*(n-1)*(n-2)*...*3*2*1 and 0! = 1.

The standard set of tests is run whenever the detection rate for both Material Disposal Area (MDA) H and Laboratory background is greater than 50%; if there are fewer than 50% in either set, then the Gehan test is not applicable.

E-3.0 STATISTICAL RESULTS

MDA H Resource Conservation and Recovery Act facility investigation (RFI) data include sediment samples and subsurface tuff samples from four borehole locations. The locations of the disposal shafts and the sampling locations are shown in Figure 2.2-1, Section 2.

E-3.1 Sediment Sample Results

MDA H has a single primary drainage channel that runs to the southeast. An on-site geomorphic analysis of the channel determined the locations of depositional areas (e.g., low areas, behind obstructions); eight sample locations were selected within these depositional areas. All samples were field screened for alpha, beta, and gamma radiation to determine sample selection for laboratory analysis. The sample with the highest gross gamma level and three other samples were shipped to a contract laboratory for analysis of target analyte list (TAL) metals, cyanide, PCBs, pesticides, and radionuclides. The four sample locations sent for contract laboratory analysis are indicated in Figure 2.2-1, Section 2. One sample location (54-5126) was in an area where water ponds near the southeast corner of MDA H, two sample locations (54-5130 and 54-5131) were at small depositional areas for coarse sediment (field notes describe the sample media as sand/gravel), and one sample location (54-5132) was along the sandy bed of a tributary into Pajarito Canyon.

E-3.1.1 Inorganic Chemicals

Inorganic chemical concentrations were compared with Laboratory-wide BVs for canyon sediments (Ryti et al. 1998, 59730). The inorganic chemicals are summarized in Table E-3.1-1.

The distribution of concentrations (and DLs for nondetects) and the distribution of concentrations from the canyon sediments background data set are presented in Figure E-3.1-1. The figures show that the distributions of concentrations for most inorganic chemicals are no larger than the distribution of background concentrations. For most analytes, there are no results above the Laboratory-wide sediment BVs, and the distributions appear to be shifted lower than the Laboratory background distribution. The only exceptions, lead, selenium, and cadmium, are discussed below.

Table E-3.1-1
Summary of Inorganic Chemical Analyses of MDA H Channel Sediment Samples

Analyte	Number of Samples	Nondetects			Detects					BV Comparison		
		Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum	Sediment BV	DL Greater than BV	Detects Greater than BV
Aluminum	4	0	n/a*	n/a	4	1140	2675	2822	4800	15400	0	0
Antimony	4	4	0.2	0.2	0	n/a	n/a	n/a	n/a	0.83	0	0
Arsenic	4	4	0.91	1.7	0	n/a	n/a	n/a	n/a	3.98	0	0
Barium	4	1	32.4	32.4	3	45.2	51.3	55.83	71	127	0	0
Beryllium	4	4	0.2	0.39	0	n/a	n/a	n/a	n/a	1.31	0	0
Boron	4	4	1.6	1.6	0	n/a	n/a	n/a	n/a	None	n/a	n/a
Cadmium	4	4	0.26	0.68	0	n/a	n/a	n/a	n/a	0.4	3	0
Calcium	4	2	912	976	2	1430	1510	1510	1590	4420	0	0
Chromium	4	0	n/a	n/a	4	2.4	2.85	3.225	4.8	10.5	0	0
Cobalt	4	4	1.7	4.6	0	n/a	n/a	n/a	n/a	4.73	0	0
Copper	4	4	2.1	4.1	0	n/a	n/a	n/a	n/a	11.2	0	0
Cyanide	4	4	0.2	0.28	0	n/a	n/a	n/a	n/a	0.5	0	0
Iron	4	0	n/a	n/a	4	3690	3900	4345	5890	13800	0	0
Lead	4	0	n/a	n/a	4	13.1	17.6	17.4	21.3	19.7	0	2
Magnesium	4	4	513	948	0	n/a	n/a	n/a	n/a	2370	0	0
Manganese	4	0	n/a	n/a	4	116	206.5	207.2	300	543	0	0
Mercury	4	4	0.02	0.02	0	n/a	n/a	n/a	n/a	0.1	0	0
Molybdenum	4	4	5.2	5.3	0	n/a	n/a	n/a	n/a	None	n/a	n/a
Nickel	4	4	1.2	2.9	0	n/a	n/a	n/a	n/a	9.38	0	0
Potassium	4	4	195	723	0	n/a	n/a	n/a	n/a	2690	0	0
Selenium	4	4	0.6	0.61	0	n/a	n/a	n/a	n/a	0.3	4	0
Silver	4	4	0.6	0.61	0	n/a	n/a	n/a	n/a	1	0	0
Sodium	4	4	28.7	67.5	0	n/a	n/a	n/a	n/a	1470	0	0
Thallium	4	4	0.2	0.2	0	n/a	n/a	n/a	n/a	0.73	0	0
Vanadium	4	3	6.7	7.1	1	11.2	11.2	11.2	11.2	19.7	0	0
Zinc	4	0	n/a	n/a	4	0.2	17.4	17.57	35.3	60.2	0	0

Note: All concentrations are in mg/kg.
* n/a = not applicable.

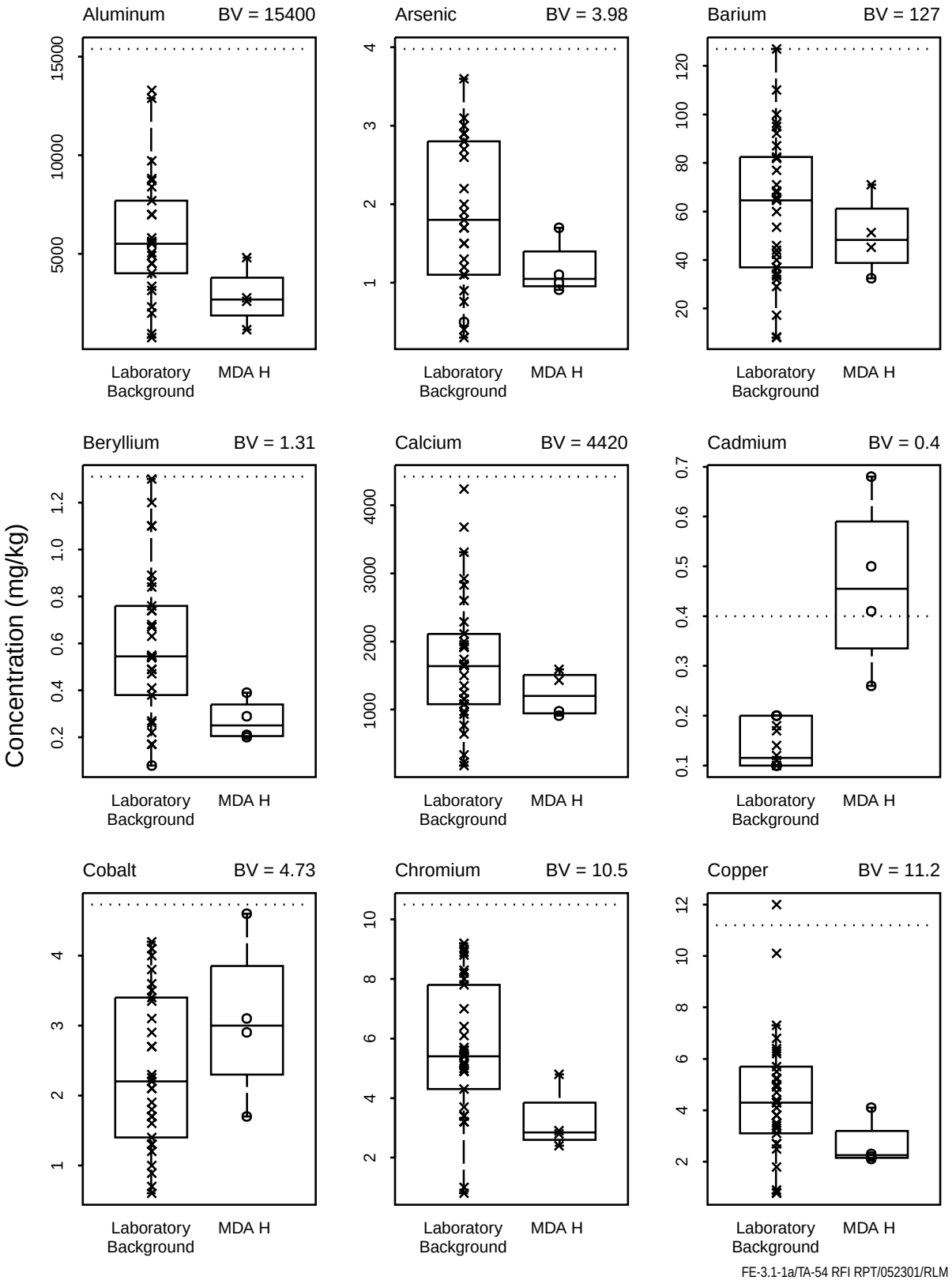

Figure E-3.1-1. Box plots of inorganic chemical concentrations from channel sediments at MDA H and from canyons sediments in Laboratory background

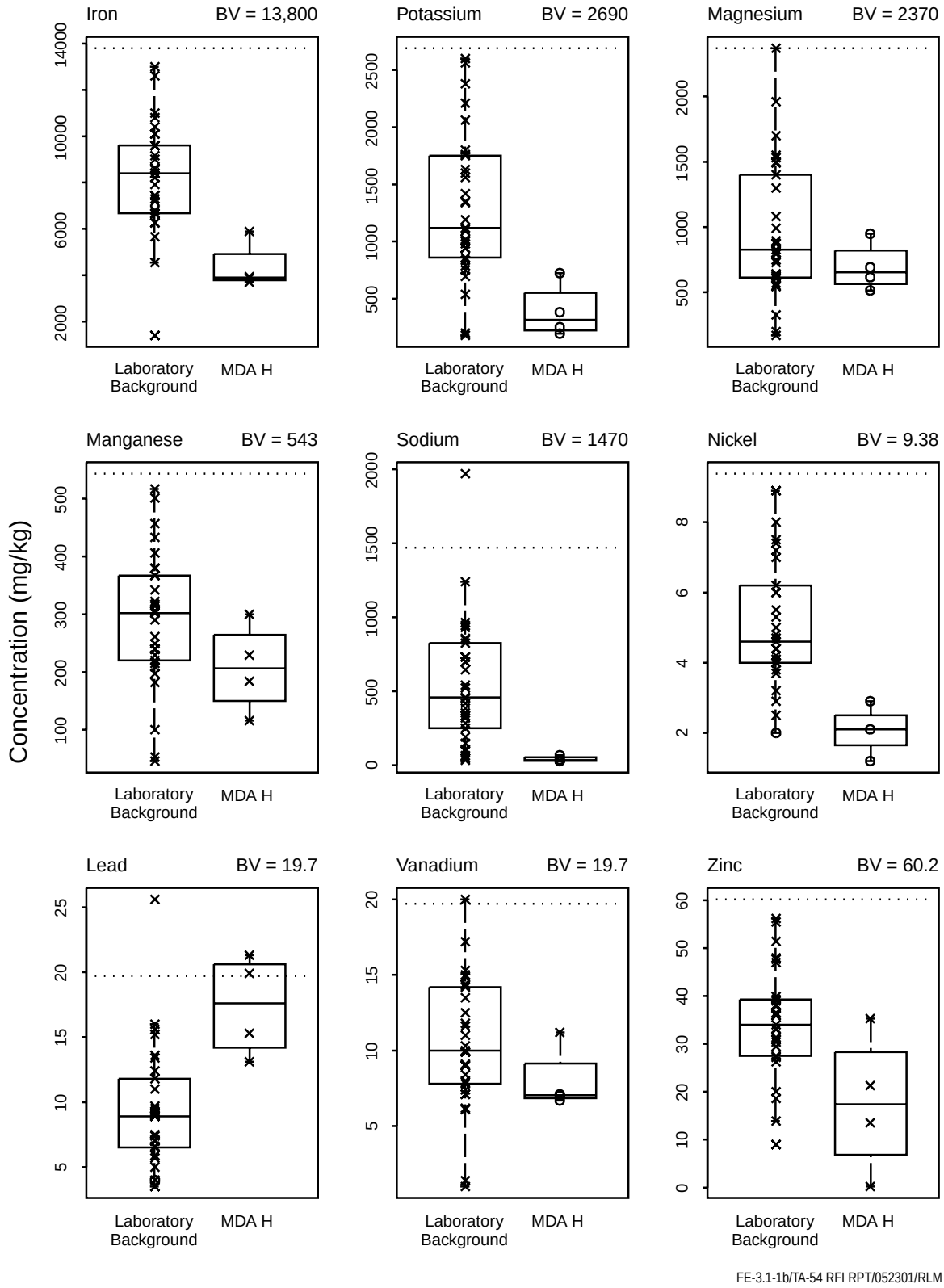

Figure E-3.1-1 (continued). Box plots of inorganic chemical concentrations from channel sediments at MDA H and from canyons sediments in Laboratory background

Lead was detected above the Laboratory-wide sediment BV in the two coarse sediment (sand/gravel) samples (sample locations 54-5130 and 54-5131). Background comparison tests were not conducted because too few samples were collected. However, a box plot (Figure E-3.1-1) illustrates that the range of values in the two data sets are similar. Therefore, lead is not a chemical of potential concern (COPC) at MDA H. Cadmium was reported below the DL (i.e., not detected) in all channel sediment samples. However, the analytical DLs for three of the four samples exceed the cadmium sediment BV. Therefore, cadmium is retained as a COPC. Selenium was reported below the DL (i.e., not detected) in all channel sediment samples. The DLs were larger than the BV. Therefore, selenium is retained as a COPC.

E-3.1.2 Radionuclides

The channel sediment samples were analyzed for radionuclides. The detected radioactivity concentrations for americium-241, cesium-137, tritium, plutonium-238, plutonium-239, and strontium-90 were compared with sediment fallout values (FVs) (Table E-3.1-2). The isotopes in the uranium and thorium decay chains were compared with sediment and soil BVs for these naturally occurring radiochemicals. The fallout concentrations and BVs are listed in the Laboratory background document (Ryti et al. 1998, 59730).

Table E-3.1-2
Summary of Radionuclide Analyses of MDA H Channel Sediment Samples

Analyte	Number of Samples	Nondetects			Detects					BV Comparison	
		Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum	Sediment FV/BV	Detects Greater Than FV/BV
Fallout Radionuclides											
Americium-241	4	0	n/a*	n/a	4	0.003	0.0045	0.005	0.008	0.04	0
Cesium-137	4	2	0.08	0.11	2	0.3	0.39	0.39	0.48	0.9	0
Tritium	4	0	n/a	n/a	4	0.004	0.009	0.03325	0.111	0.093	1
Plutonium-238	4	0	n/a	n/a	4	0.001	0.0015	0.00175	0.003	0.006	0
Plutonium-239	4	0	n/a	n/a	4	0.001	0.0025	0.00575	0.017	0.068	0
Strontium-90	4	0	n/a	n/a	4	-0.02	0.005	0.0325	0.14	1.04	0
Natural Radionuclides											
Radium-226	4	3	0.25	0.41	1	1.23	1.23	1.23	1.23	2.59	0
Thorium-228	4	0	n/a	n/a	4	0.84	1.055	1.042	1.22	2.28	0
Thorium-230	4	0	n/a	n/a	4	0.76	0.925	0.955	1.21	2.29	0
Thorium-232	4	0	n/a	n/a	4	0.87	1.105	1.095	1.3	2.33	0
Uranium-234	4	0	n/a	n/a	4	0.71	0.88	0.9525	1.34	2.59	0
Uranium-235	4	0	n/a	n/a	4	0.05	0.06	0.0625	0.08	0.2	0
Uranium-238	4	0	n/a	n/a	4	0.77	1.025	1.045	1.36	2.29	0

Note: All concentrations are in pCi/g.
* n/a = not applicable.

Only tritium was reported as detected above its sediment FV. The detected activity concentration for tritium (0.111 pCi/g) in one channel sediment sample marginally exceeded the associated sediment FV (0.093 pCi/g). Statistical background comparison tests were not conducted because too few samples were collected. Tritium was retained as a COPC.

E-3.1.3 Organic Chemicals

The four channel sediment samples were analyzed for pesticides and PCBs. Only one organic chemical (methoxychlor) was reported at trace concentrations. Methoxychlor was detected in two of four samples at concentrations of 0.036 mg/kg (sample location 54-5130) and 0.04 mg/kg (sample location 54-5132); the reported concentrations are approximately double the sample EQL (0.017 mg/kg). Methoxychlor is retained as a COPC. A summary of the organic chemical suite is listed in Table E-3.1-3.

Table E-3.1-3
Summary of Organic Chemical Analyses of MDA H Channel Sediment Samples

		Nondetects			Detects				
Pesticide/PCB	Number of Samples	Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum
Aroclor-1016	4	4	0.033	0.033	0	n/a*	n/a	n/a	n/a
Aroclor-1221	4	4	0.067	0.068	0	n/a	n/a	n/a	n/a
Aroclor-1232	4	4	0.033	0.033	0	n/a	n/a	n/a	n/a
Aroclor-1242	4	4	0.033	0.033	0	n/a	n/a	n/a	n/a
Aroclor-1248	4	4	0.033	0.033	0	n/a	n/a	n/a	n/a
Aroclor-1254	4	4	0.033	0.033	0	n/a	n/a	n/a	n/a
Aroclor-1260	4	4	0.033	0.033	0	n/a	n/a	n/a	n/a
Aldrin	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
BHC [alpha-]	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
BHC [beta-]	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
BHC [delta-]	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Chlordane [alpha-]	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Chlordane [gamma-]	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
DDD [p,p'-]	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
DDE [p,p'-]	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
DDT [p,p'-]	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Dieldrin	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Endosulfan I	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Endosulfan II	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Endosulfan sulfate	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Endrin	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Endrin aldehyde	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Endrin ketone	4	4	0.0033	0.0033	0	n/a	n/a	n/a	n/a
Heptachlor	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Heptachlor epoxide	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Lindane	4	4	0.0017	0.0017	0	n/a	n/a	n/a	n/a
Methoxychlor	4	2	0.017	0.017	2	0.036	0.038	0.038	0.04
Toxaphene	4	4	0.171	0.172	0	n/a	n/a	n/a	n/a

Note: All concentrations are in mg/kg.

* n/a = not applicable.

E-3.2 Subsurface Tuff

Four vertical boreholes were drilled in the immediate vicinity of the nine inactive disposal shafts (Figure 2.2-1, Section 2). From these boreholes, 33 core tuff samples were collected for fixed laboratory analyses, 13 from unit 2 Tshirege Member (Qbt 2) and 20 from the unit 1v Tshirege Member (Qbt 1v). One field duplicate from Qbt 1v was collected for quality assurance/quality control purposes to evaluate the variability of the analytical chemistry results. The samples were analyzed for TAL metals and cyanide, pesticides/PCBs, SVOCs, VOCs, tritium, and gamma-emitting radionuclides.

E-3.2.1 Inorganic Chemicals

Inorganic chemical results for samples collected from the Qbt 2 unit were compared with the BVs for upper Qbt units (Qbt 2, Qbt 3, Qbt 4), and samples collected from the Qbt 1v unit were compared with Qbt 1v BVs (Ryti et al. 1998, 59730). The data are summarized in Table E-3.2-1.

Table E-3.2-1
Summary of Inorganic Chemical Analyses from MDA H Subsurface Tuff Units

Analyte	Unit	Number of Samples	Nondetects			Detects					BV Comparison		
			Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum	Unit BV	DL Greater than BV	Detects Greater than BV
Aluminum	Qbt 2	13	0	n/a*	n/a	13	187	756	1093	3140	7340	0	0
	Qbt 1v	20	0	n/a	n/a	20	167	240	454.9	2570	8170	0	0
Antimony	Qbt 2	13	11	0.1	4.93	2	0.39	0.48	0.48	0.57	0.5	3	1
	Qbt 1v	20	20	0.1	5.04	0	n/a	n/a	n/a	n/a	0.5	4	0
Arsenic	Qbt 2	13	9	0.198	0.93	4	1	1.15	1.35	2.1	2.79	0	0
	Qbt 1v	20	12	0.192	0.31	8	0.309	1.05	0.9436	1.8	1.81	0	0
Barium	Qbt 2	13	0	n/a	n/a	13	2.8	6.4	7.306	18	46	0	0
	Qbt 1v	20	0	n/a	n/a	20	1.7	4.4	4.755	10.7	26.5	0	0
Beryllium	Qbt 2	13	4	0.08	0.493	9	0.13	0.22	0.2556	0.44	1.21	0	0
	Qbt 1v	20	4	0.49	0.504	16	0.1	0.185	0.2038	0.49	1.7	0	0
Cadmium	Qbt 2	13	12	0.02	0.493	1	0.25	0.25	0.25	0.25	1.63	0	0
	Qbt 1v	20	18	0.02	0.504	2	0.25	0.385	0.385	0.52	0.4	4	1
Calcium	Qbt 2	13	0	n/a	n/a	13	155	470	487.2	776	2200	0	0
	Qbt 1v	20	0	n/a	n/a	20	202	509.5	496.6	754	3700	0	0
Chromium	Qbt 2	13	4	0.3	0.987	9	0.57	1.9	3.027	7	7.14	0	0
	Qbt 1v	20	8	0.3	1.01	12	0.32	0.775	0.9517	3	2.24	0	1
Cobalt	Qbt 2	13	5	0.4	0.987	8	0.14	0.605	0.7462	1.8	3.14	0	0
	Qbt 1v	20	15	0.4	1.01	5	0.14	0.26	0.284	0.43	1.78	0	0
Copper	Qbt 2	13	4	0.5	1.35	9	0.82	1.1	12.09	35.4	4.66	0	4
	Qbt 1v	20	5	0.5	1.33	15	0.37	0.78	0.8547	1.7	3.26	0	0
Cyanide	Qbt 2	12	12	0.15	1.01	0	n/a	n/a	n/a	n/a	0.5	2	0
	Qbt 1v	20	20	0.15	1.02	0	n/a	n/a	n/a	n/a	0.5	4	0

Table E-3.2-1 (continued)

Analyte	Unit	Number of Samples	Nondetects			Detects					BV Comparison		
			Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum	Unit BV	DL Greater than BV	Detects Greater than BV
Iron	Qbt 2	13	0	n/a	n/a	13	685	1570	2125	4650	14500	0	0
	Qbt 1v	20	0	n/a	n/a	20	250	1450	1960	5330	9900	0	0
Lead	Qbt 2	13	0	n/a	n/a	13	1.3	2.4	3.918	16.2	11.2	0	1
	Qbt 1v	20	0	n/a	n/a	20	1.02	1.75	3.413	27.2	18.4	0	1
Magnesium	Qbt 2	13	0	n/a	n/a	13	27.8	97.6	134.1	400	1690	0	0
	Qbt 1v	20	0	n/a	n/a	20	26.7	56.2	79.92	321	780	0	0
Manganese	Qbt 2	13	0	n/a	n/a	13	49.6	93.9	106.7	212	482	0	0
	Qbt 1v	20	0	n/a	n/a	20	44.8	97.75	110.4	238	408	0	0
Mercury	Qbt 2	13	13	0.02	0.1	0	n/a	n/a	n/a	n/a	0.1	0	0
	Qbt 1v	20	17	0.02	0.07	3	0.06	0.06	0.0633	0.07	0.1	0	0
Nickel	Qbt 2	13	5	0.6	1.48	8	0.96	2.55	3.083	6	6.58	0	0
	Qbt 1v	20	15	0.6	1.51	5	0.62	1	1.052	1.9	2	0	0
Potassium	Qbt 2	13	1	90	90	12	92.1	190.5	364	871	3500	0	0
	Qbt 1v	20	5	89.9	92.1	15	98.4	153	159.4	271	6670	0	0
Selenium	Qbt 2	13	12	0.2	0.95	3	0.27	0.27	0.27	0.27	0.3	5	0
	Qbt 1v	20	19	0.2	0.46	1	0.31	0.31	0.31	0.31	0.3	5	1
Silver	Qbt 2	13	13	0.1	1.3	0	n/a	n/a	n/a	n/a	1	1	0
	Qbt 1v	20	19	0.1	0.504	1	0.712	0.712	0.712	0.712	1	0	0
Sodium	Qbt 2	13	0	n/a	n/a	13	64.9	272	323.5	776	2770	0	0
	Qbt 1v	20	0	n/a	n/a	20	78.9	136	171.1	382	6330	0	0
Thallium	Qbt 2	13	12	0.1	0.48	1	1.7	1.7	1.7	1.7	1.1	0	1
	Qbt 1v	20	20	0.1	0.5	0	n/a	n/a	n/a	n/a	1.24	0	0
Vanadium	Qbt 2	13	1	0.987	0.987	12	0.94	1.4	1.777	3.8	17	0	0
	Qbt 1v	20	4	0.98	1.01	16	0.7	1.55	1.586	3.3	4.48	0	0
Zinc	Qbt 2	13	0	n/a	n/a	13	8.39	15.5	19.54	32.5	63.5	0	0
	Qbt 1v	20	0	n/a	n/a	20	6.98	18.85	22.73	45	84.6	0	0

Note: All concentrations are in mg/kg.

* n/a = not applicable.

All inorganic chemical analytes identified in the BV comparison as having one or more detected concentrations (or DLs for nondetected chemicals) above BVs are presented in Figures E-3.2-1 and E-3.2-2. These figures show the profile or pattern of analytical concentrations by depth (below ground surface) within the individual boreholes. Detected concentrations (filled circles) and DLs for nondetects (open circles) are plotted, and unit-specific BVs are shown as dotted lines. These profiles are used to identify patterns that might be associated with a release. Evidence for such a release would be the detection of concentrations greater than BVs at two or more consecutive depths rather than at sporadic depths across boreholes.

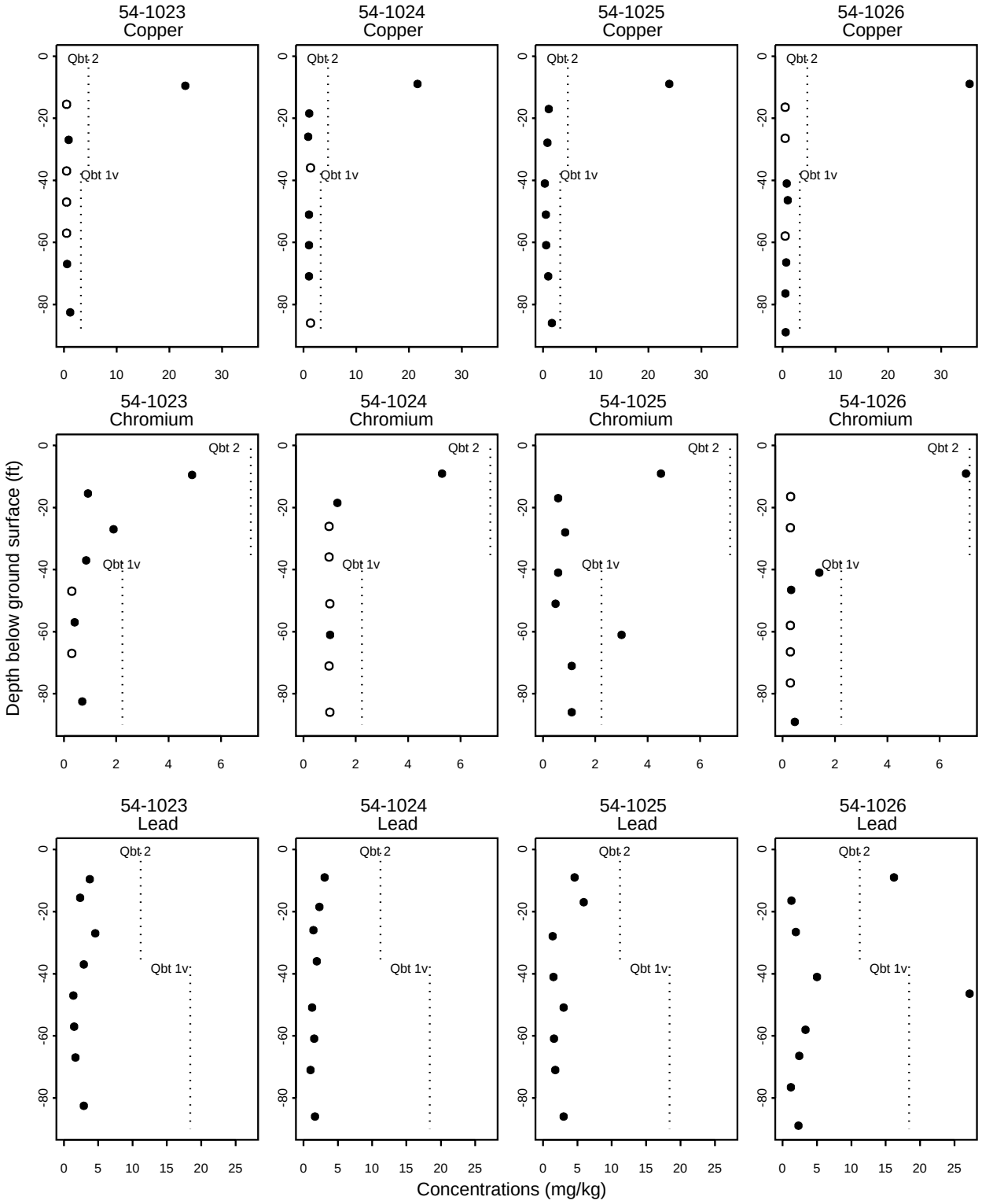

Figure E-3.2-1. Borehole profile plot for detected inorganic chemicals

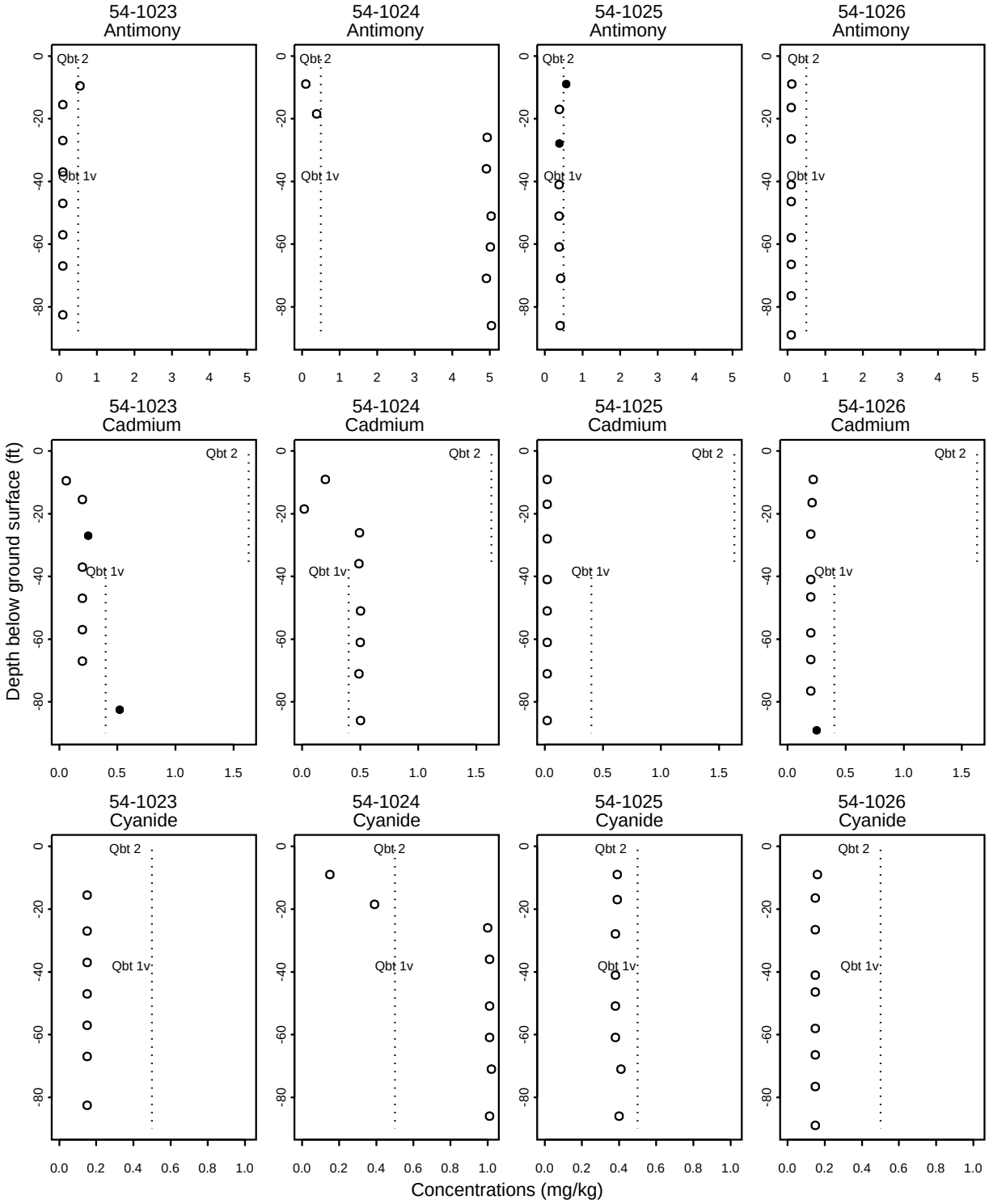

Figure E-3.2-2. Borehole profile plot for undetected inorganic chemicals

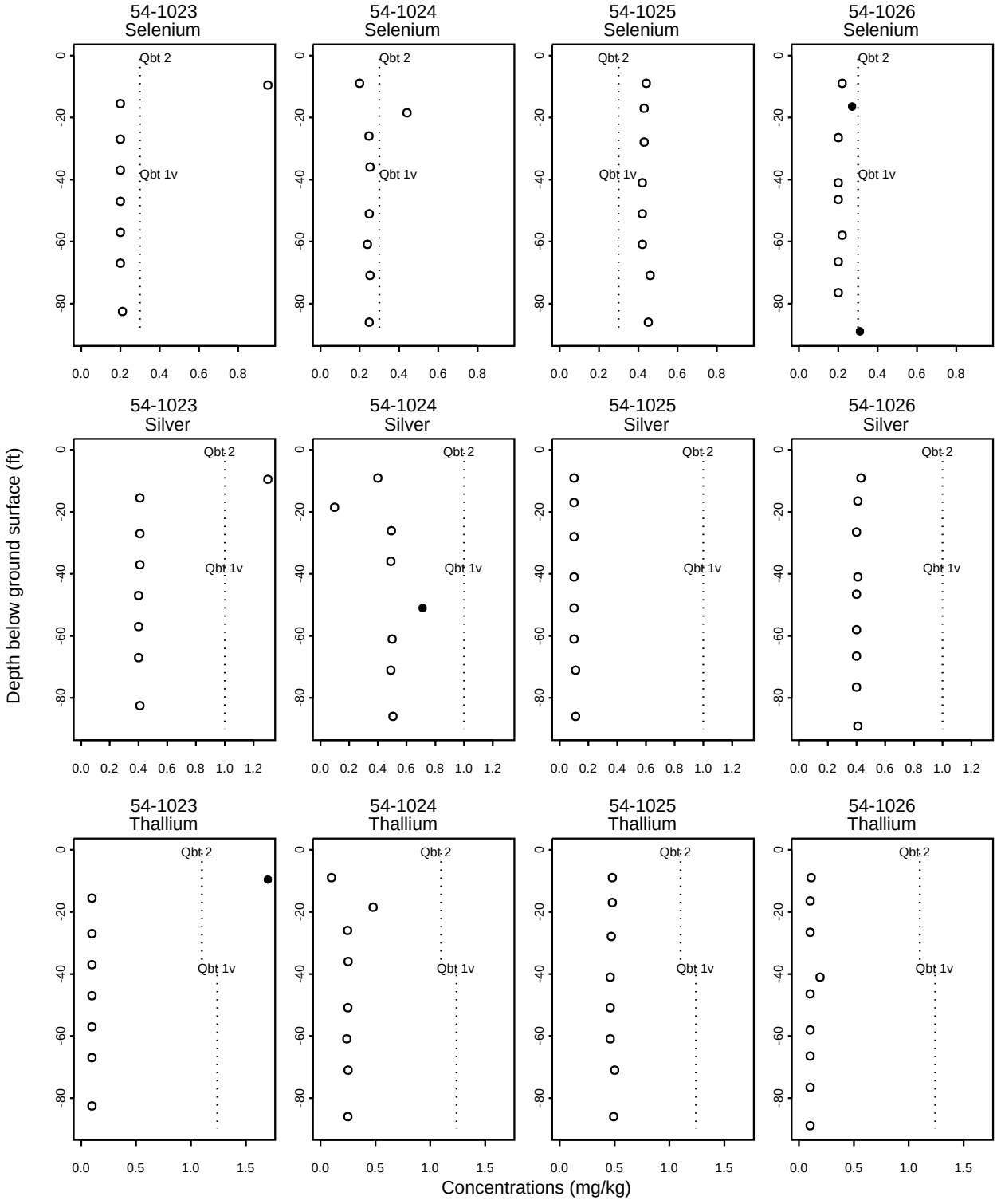

Figure E-3.2-2 (continued). Borehole profile plot for undetected inorganic chemicals

Copper (Qbt 2), chromium (Qbt 1v), and lead (Qbt 2 and Qbt 1v) were detected above their BVs (Figure E-3.2-1). Concentrations of copper were three to four times greater than the BV in all four boreholes at the uppermost sampling depth (approximately 10 ft below ground surface), but concentrations dropped below BVs in all deeper core samples. Chromium and lead concentrations above BVs were fewer, at concentrations less than 1.5 times the BV, and bounded below by concentrations below BVs. Only borehole 54-1026 had two lead concentrations above BVs, but these were separated by more than 30 ft and that interval included three samples with concentrations below BVs. No single depth within a borehole contained multiple analytes above BVs. The sporadic spatial pattern of exceedances does not provide evidence of a release of inorganic chemicals from the disposal structures. Therefore, the distribution of site concentrations was compared with the distribution of concentrations from Laboratory background samples for the same tuff unit group. For all inorganic chemicals that are frequently detected and well characterized in tuff for both Laboratory background and at MDA H, the standard set of background comparison tests (Gehan, quantile, and slippage) were performed. In general, the results indicate that concentrations at MDA H are not greater than those in the Laboratory background data sets (p-values >0.05 for all analytes for all tests, Table E-3.2-2). For analytes that are infrequently detected, the rates of detection for MDA H and Laboratory background were compared, and the ranges of detected concentrations and DLs for both sets were evaluated. In some cases, there were enough detected concentrations in both data sets so that quantile and/or slippage tests could be run. For data sets with any DLs larger than BVs, the background comparison tests were modified in the following way. All site nondetects with DLs larger than BVs were considered as detected at their reported DL when running the background comparison tests. The test results based on treating the large DLs as detects are listed in Table E-3.2-2 as DL-mod. Some of the analytes were not analyzed in the Laboratory background study and are discussed below.

The background comparison tests concluded that chromium and lead are not significantly different from background concentrations (all p-values >0.05, Table E-3.2-2), but the distribution of copper concentrations is significantly different from background concentrations (slippage test is significant, p-value = 0.0005, Table E-3.2-2).

The four large copper concentrations were collected from within an interval of less than 4 ft beginning at about 10 ft bgs and at distances of 5 ft to 30 ft between the individual boreholes and the nearest disposal shaft. Transport of copper from the surface or by way of near lateral movement through tuff from the disposal shafts are possible explanations of elevated concentrations. No large copper concentrations were recorded in surface sediment samples to support the explanation of surface contamination. The shafts received minimal liquid to drive transport; they were covered when not in use and capped upon closure, and inventory lists include no liquid disposal. Another possible explanation is natural variability similar to other documented heterogeneities (enrichments) of particular inorganic chemicals in the Bandelier Tuff because of remobilization by vapor-phase processes during welding/devitrification (Stimac et al. 1996, 59362). Copper is one of the inorganic chemicals identified as affected by these processes. A tuff core sample within this same elevation interval and in close proximity (from a borehole at MDA J and approximately 200 ft away) reported a copper concentration of 24 mg/kg (the range of concentrations at MDA H for the interval was 21.6 mg/kg to 35.4 mg/kg); all other sampling depths at MDA J were at least 5 ft lower in elevation and produced concentrations below BVs.

The remaining inorganic chemicals, antimony, cadmium, cyanide, selenium, silver, and thallium, had some detected concentrations and/or nondetects reported at DLs just above BVs (Figure E-3.2-2). The Laboratory background samples for these analytes include few detected concentrations, and the BVs are nominal analytical DLs (except for thallium). The DLs at MDA H reported above BVs occurred in blocks of samples within the same laboratory request number, indicating that these DLs are associated with a laboratory batch rather than a borehole location. The rates of detection for these analytes were compared

with the rates observed in the Laboratory background data sets; the tests concluded that the detection rates were not significantly different (Table E-3.2-2). The range of DLs at MDA H was compared with that in the background data sets. In general, the DLs are at reasonable concentrations, indicating that the analytes were not present above background levels.

The detection rate for antimony in MDA H cores was not significantly different from the detection rate in Laboratory background (Table E-3.2-2). Six MDA H samples were analyzed by inductively coupled plasma emission spectroscopy (ICPES), resulting in high DLs (approximately 5.0 mg/kg) that are above the BV (0.5 mg/kg, a nominal DL). The remainder of the samples were analyzed by inductively coupled plasma mass spectroscopy, the method used for the Laboratory background samples. If the ICPES results are removed as inadequate, all DLs in Qbt 1v are below the BVs, and in Qbt 2, only one DL (0.55 mg/kg) and one detected concentration (0.57 mg/kg) remain above the BVs. Background comparisons for the Qbt 2 samples modified by excluding the ICPES results and treating the DL larger than BV as a detect (DL-mod) indicated that MDA H concentrations are not significantly different from background (quantile test and slippage test p-value >0.05).

Table E-3.2-2.
Background Comparison Test Results (p-values) for Inorganic Chemicals in Tuff at MDA H

Analyte	Unit	Gehan Test	Quantile Test	Slippage Test	Quantile DL-mod	Chi-Square Test (Detection Rate)
Copper	Qbt2	0.15	0.22	0.0005	—*	—
Lead	Qbt2	0.99	0.96	0.17	—	—
Chromium	Qbt1v	0.77	0.83	0.47	—	—
Lead	Qbt1v	1.00	1.00	0.47	—	—
Antimony	Qbt2	—	—	0.14 (DL-mod)	0.12 (q = 0.88)	0.12
Selenium	Qbt2	—	—	—	—	0.46
Silver	Qbt2	—	—	—	—	1.00
Thallium	Qbt2	—	—	1.00 (DL-mod)	0.083(q = .85)	0.44
Cadmium (vs Qbt 2)	Qbt1v	—	1.00	1.00	—	<0.0001
Selenium (vs Qbt 2)	Qbt1v	—	—	—	—	1.00

* A dash indicates that the test was not performed.

Cadmium was detected twice in Qbt 1v core samples with one concentration (0.52 mg/kg) above the BV (0.4 mg/kg, a nominal DL), and there were four DLs marginally above the BV (0.49 mg/kg to 0.5 mg/kg). There were no Qbt 1v Laboratory backgound samples analyzed for cadmium, so no comparison could be made. If the MDA H sample concentrations are compared with the Laboratory background concentrations from the upper Qbt units (Qbt 2, Qbt 3, and Qbt 4), all MDA H results are below the BV (1.63 mg/kg). If the four MDA H nondetects with DLs above the DL observed in Laboratory background (0.2 mg/kg) are treated as detects (DL-mod), the modified background comparisons tests indicate that MDA H concentrations are less than those in background (quantile and slippage test p-values are >0.05).

Cyanide was never detected in tuff core samples. The majority of the DLs were below the BV of 0.5 mg/kg (a nominal DL). There were six DLs from one request number that were approximately double the BV (1 mg/kg to 1.02 mg/kg). Cyanide was not analyzed in Laboratory background tuff samples, so there are no results for comparison.

Selenium was detected once in Qbt 2 core samples and once in Qbt 1v core samples at concentrations (0.27 mg/kg and 0.31 mg/kg) that are approximately equal to the BV (0.3 mg/kg, a nominal DL). In addition, there were 10 samples with elevated DLs (nine DLs between 0.42 mg/kg and 0.46 m/kg and a

DL of 0.95 mg/kg). Only 15 Laboratory background tuff samples were analyzed for selenium, and none produced detected concentrations. There are insufficient Laboratory background tuff results for further comparisons.

Silver was not detected above the BV in tuff core samples at MDA H. In Qbt 2, one sample has a DL (1.3 mg/kg) above the BV (1.0 mg/kg) but smaller than the maximum detected concentration (1.9 mg/kg) in the Laboratory background data set for this tuff unit. The detection rate at MDA H is lower than for Laboratory background, and the DLs are within the range of the Laboratory results (DLs plus detected concentrations). Silver is not considered elevated above background.

Thallium was detected once in Qbt 2 core samples at a concentration (1.7 mg/kg) larger than the BV (1.1 mg/kg) but within the range of detected concentrations in Laboratory background tuff upper units. All the DLs at MDA H were below the BVs, but four of them were larger than the DLs observed in the Laboratory background samples. When treating these four larger DLs as detects, the modified background comparisons indicate that concentrations at MDA H are not significantly different from background ($p > 0.05$).

E-3.2.2 Radionuclides

Core samples were analyzed for tritium by liquid scintillation and for a suite of radionuclides by gamma spectroscopy. The Environmental Restoration (ER) Project did not evaluate all the radionuclides in the gamma spectroscopy suite. The full-suite analyte list, which is given in the ER Project analytical services statement of work (LANL 1995, 49738), includes the decay series of the naturally occurring radionuclides, uranium-235, uranium-238, and thorium-232, as well as fission and activation products and their progeny. Measurements of naturally occurring radionuclides known to be present in Laboratory soils provide an indication of the quality of the gamma spectroscopy analysis.

Actinium-228, barium-140, bismuth-212, neptunium-237, protactinium-231, protactinium-234m, lead-210, lead-211, radium-223, radium-224, radium-226, and radon-219 are not reliably measured by gamma spectroscopy and will not be evaluated as potential contaminants. Of the radionuclides that are reliably analyzed by gamma spectroscopy, 10 have half-lives of less than 365 days and are not considered to be COPCs. Data for many of these short-lived radionuclides can be useful when evaluating parent radionuclide data because the relative activity concentration of parent and daughter isotopes is a known quantity. These data are used by the analytical laboratory as well as by the ER Project during baseline data validation. The naturally occurring radionuclide potassium-40 is present in Laboratory soils at concentrations ranging between 25 pCi/g and 40 pCi/g and is always present in the gamma spectrum of Laboratory soil samples. The potassium-40 gamma emission peak provides a qualitative indicator of the accuracy of the gamma spectroscopy measurement. Potassium-40 is not considered to be a potential historical contaminant at MDA H and will not be further evaluated. The radionuclides that are evaluated in this report are those considered to be potential historical contaminants at ER Project sites. They include naturally occurring uranium-235 and seven fission and activation products (americium-241, cesium-134, cesium-137, cobalt-60, europium-152, ruthenium-106, and sodium-22). Uranium-235 is compared with Laboratory-wide BVs for the appropriate tuff unit group (Ryti et al. 1998, 59730), and the other radionuclides are evaluated on the basis of detection status. The summary and evaluation are presented in Table E-3.2-3.

Tritium is the only radionuclide detected in tuff samples at MDA H and is considered a COPC. The likely source is waste disposed of in shaft 4, although tritium-contaminated waste could potentially have been disposed of in any of the shafts. Tritium measured in core samples is associated with residual moisture (pore water and water vapor) within the tuff. Transport of tritium through the subsurface occurs as water

vapor. Tritium concentrations maximized at depths between 30 ft and 50 ft below ground surface and subsequently decreased by two to three orders of magnitude in the lower depths (Figures 2.3-6 and 3.1-1).

Table E-3.2-3
Summary of Radionuclide Analyses in Tuff Samples at MDA H

Analyte	Media	Number of Samples	Nondetects			Detects					BV Comparison	
			Number of Samples	Minimum DL	Maximum DL	Number of Samples	Minimum	Median	Mean	Maximum	Detect or Above BVs	Frequency of Detects
Fallout Radionuclides												
Americium-241	Tuff	33	33	-0.108	0.37	0	n/a*	n/a	n/a	n/a	Detect	0/33
Cesium-134	Tuff	17	17	0.05	0.14	0	n/a	n/a	n/a	n/a	Detect	0/17
Cesium-137	Tuff	33	33	-0.032	0.1	0	n/a	n/a	n/a	n/a	Detect	0/33
Cobalt-60	Tuff	33	33	-0.03	0.09	0	n/a	n/a	n/a	n/a	Detect	0/33
Europium-152	Tuff	16	16	-0.07	0.232	0	n/a	n/a	n/a	n/a	Detect	0/16
Ruthenium-106	Tuff	33	33	-0.439	0.67	0	n/a	n/a	n/a	n/a	Detect	0/33
Sodium-22	Tuff	33	33	-0.0518	0.08	0	n/a	n/a	n/a	n/a	Detect	0/33
Tritium (pCi/mL)	Tuff	33	11	1.34	197000	23	253	6644	75090	777,000	Detect	23/33
Natural Radionuclides												
Uranium-235	Qbt 2	6	6	0.11	0.13	0	n/a	n/a	n/a	n/a	0.09	0/0
Uranium-235	Qbt 1v	11	11	0.11	0.13	0	n/a	n/a	n/a	n/a	0.14	0/0

Note: All concentrations are in pCi/g, unless otherwise noted.

* n/a = not applicable.

The maximum reported concentration of tritium at MDA H of approximately 777,000 pCi/mL is associated with a reported moisture content of 0.2%. Tritium concentrations for samples that report very low moisture content are very unreliable. Tritium concentrations stabilize and, hence, are more consistent when the moisture content is 3% or greater. Consequently, although a tritium plume exists at MDA H, the potential magnitude of the plume is not necessarily well described by this data point. The analytical laboratory total propagated uncertainty results for all measurements with low reported moisture content (request number 651, all results for location 54-1024) are larger than the reported concentrations, supporting the assumption that these measurements are more variable and less reliable.

E-3.2.3 Organic Chemicals

Tuff samples were analyzed for PCBs, pesticides, SVOCs, and VOCs. Only 18 organic chemicals (5 SVOCs, 1 pesticide, and 12 VOCs) were detected in one or more of the 33 core samples. Of these detected organic chemicals, 16 were reported at trace concentrations below the EQL. Trichlorofluoromethane was reported marginally above the EQL, and bis-2-ethylhexylphthalate exceeded the EQL. The organic chemical analytes with one or more detected concentrations are summarized in Table E-3.2-4.

Table E-3.2-4
Summary of Organic Chemicals in Tuff Samples at MDA H

Suite/Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)*	Frequency of Detects	EQL	Detected Concentration Range (mg/kg)
SVOCs						
Benzoic acid	33	1	0.49–[3.5]	1/33	3.5	0.49
Bis(2-ethylhexyl) phthalate	33	5	[0.038]–3.8	5/33	0.95	0.083–3.8
Di-n-butyl phthalate	33	6	0.043–[0.35]	6/33	0.35	0.043–0.057
Diethyl phthalate	33	1	0.28–[0.35]	1/33	0.35	0.28
Dimethyl Phthalate	33	1	0.042–[0.35]	1/33	0.35	0.042
Pesticide/PCB						
Endosulfan sulfate	33	1	[0.000671]–[0.00351]	1/33	0.034	0.000674
VOCs						
Acetone	33	2	[0.002]–[0.025]	2/33	0.025	0.011–0.016
Benzene	33	1	0.003–[0.0052]	1/33	0.005	0.003
Butanone [2-]	33	2	0.002–[0.021]	2/33	0.020	0.002–0.007
Butylbenzene [n-]	33	1	0.0013–[0.0052]	1/33	0.005	0.0113
Butylbenzene [sec-]	33	2	0.0011–[0.0052]	2/33	0.005	0.0011–0.0012
Hexachlorobutadiene	9	1	0.002–[0.005]	1/9	0.005	0.002
Methylene chloride	33	3	0.002–[0.011]	3/33	0.011	0.002
Naphthalene	9	1	0.001–[0.005]	1/9	0.005	0.001
Toluene	33	3	0.001–[0.0052]	3/33	0.005	0.001–0.002
Trichlorobenzene[1,2,3-]	9	2	0.001–[0.005]	2/9	0.005	0.001–0.002
Trichlorobenzene[1,2,4-]	9	1	0.001–[0.005]	1/9	0.005	0.001
Trichlorofluoromethane	33	6	0.002–0.007	6/33	0.005	0.002–0.007

* Square brackets indicate a nondetected result.

REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER record identification (ER ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 54."

Copies of the reference library are maintained at the NMED Hazardous and Radioactive Materials Bureau; the DOE Los Alamos Area Office; United States EPA, Region VI; and the ER Project Material Disposal Areas Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

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Appendix F

Risk Assessment Calculations and Ecological Scoping Checklist

APPENDIX F RISK ASSESSMENT CALCULATIONS AND ECOLOGICAL SCOPING CHECKLIST

F-1.0 EQUATION AND PARAMETERS FOR ESTIMATING TRITIUM INHALATION DOSE FROM AMBIENT AIR

The effective annual dose equivalent for inhalation of tritium in ambient air was calculated according to the following equation:

$$Dose = C_a * InhR * ET * EF * DCF_{inh} \quad ,$$

where

C_a = concentration of tritium in ambient air (1070 pCi/m^3 [Environmental Surveillance Report 1998, 59904]),
InhR = inhalation rate (1.3 m^3/hour [EPA 1997, 66596]),
ET = exposure time (8 hour/day [EPA 1991, 56140]),
EF = exposure frequency (250 day/year [EPA 1991, 56140]), and
DCF_{inh} = dose conversion factor for inhalation (6.4E-08 mrem/pCi [EPA 1988, 50123]).

F-2.0 ECOLOGICAL SCOPING CHECKLIST

Part A—Scoping Meeting Documentation

Site ID	**Technical Area 54**	
Form of Site Releases (solid, liquid, vapor) Describe all relevant known or suspected *mechanisms* of release (spills, dumping, material disposal, outfall, explosive testing) and describe potential *areas* of release. Reference locations on a map, as appropriate.	Solid, liquid, and vapor-phase contaminants have come from the release of chemicals to the waste disposal areas at Technical Area 54 (TA-54). Since 1957, various types of waste have been placed in pits and shafts underground and covered with 1 m to 3 m of clean dirt. Liquids and solids have been placed in direct contact with subsurface and surface media without the protection of containers or liners. A number of vapor-phase organics and tritium are known to diffuse from the surface and hillsides of Mesita del Buey.	
List of Primary Impacted Media Indicate all that apply.	Surface soil Surface water/sediment Subsurface Groundwater Other	Yes Not applicable Yes Not applicable Air (Part C)
Facility for Information Management, Analysis, and Display (FIMAD) Vegetation Class Based on Arcview Vegetation Coverage Indicate all that apply.	Water Bare ground/unvegetated Spruce/fir/aspen/mixed conifer Ponderosa pine Piñon juniper/juniper savannah Grassland/shrubland Developed	Not applicable Not applicable Not applicable Yes (mix on hillsides) Yes (mix on hillsides) Yes (limited on mesa top) Yes (mesa top)

Site ID	Technical Area 54
Is threatened and endangered (T&E) species habitat present? If applicable, list species known or suspected that use the site for breeding or foraging.	Potential T&E habitat is found on the mesa top or hillsides of Mesita del Buey for a number of species (for a detailed list and rationale, see Banar [1996, 58192, Chapter 6]). However, habitats for only two species are found with high frequency in the area; these include the peregrine falcon (Falco peregrinus) and the spotted bat (Euderma maculatum). These species have not been observed to roost or nest in the area. Nevertheless, Banar (1996, 58192) cautions that future disturbances to cliff tops and faces could have negative impacts on these species. Additionally, disturbances (physical, chemical) to the areas surrounding TA-54 may have negative impacts on the habitat for other species of potential concern. Consult Banar (1996, 58192) for details and mitigation recommendations.
Provide a list of neighboring/ contiguous/ upgradient sites; include a brief summary of chemicals of potential concern (COPCs) and the form of releases for relevant sites and reference a map, as appropriate. Use this information to evaluate the need to aggregate sites for screening.	Material disposal areas (MDAs) on Mesita del Buey share a geographic proximity. These areas share the same biotic character. No other potential release sites (PRSs) are present.
Surface Water Erosion Potential Information Summarize information from Standard Operating Procedure (SOP) 2.01, Rev. 0, "Surface Water Site Assessments," including the runoff subscore (maximum of 46), terminal point of surface water transport, slope, and surface water run-on sources.	There is a limited number of PRSs that have undergone SOP 2.01 (R0, "Surface Water Site Assessments") evaluation of TA-54. Many of the PRSs that have been evaluated have had either inconsequential erosion matrix scores (3.6) or very low scores (27). These scores, however, are for mesa-top PRSs and are not reflective of contaminant transport potential on the hillsides of Mesita del Buey. MDA H (PRS 54-004) has an erosion matrix score of 45.6, which indicates a moderate erosion potential. In general, from scoping investigations of the areas of concern, the factors contributing the most to the erosion potential are the percentage of ground cover and the slope of the exposed area. Additionally, structures and operations can increase erosion potential particularly if the area is not vegetated. Terminal points of surface water transport are Cañada del Buey on the northern side and Pajarito Canyon (MDA H) on the southern side. In most areas, there are no direct discharge pathways to the bottoms of these canyons, as there are often intervening benches, rocks, roads, and vegetation. This is particularly true for the southern side of Mesita del Buey. On the northern side of MDA G, there are a few direct discharge pathways to the bottom of Cañada del Buey from the mesa top.
Other Scoping Meeting Notes	The mesa top is fenced off from the surrounding hillsides and is managed intensively to limit access to the area by large ground-dwelling animals (e.g., deer, elk, mountain lions); some limitations may apply to foxes, coyotes, raccoons, bobcat, or other medium-size mammals. The hillsides represent an intact biotic community. The mesa top is occupied by a limited number of species and is characterized by a relatively diverse biotic community.

Part B—Site Visit Documentation

Site ID	TA-54
Date of Site Visit	Mesa top: April 13, 1999. Hillsides: June 10, 1999
Site Visit Conducted by	Mark Hooten and Randy Ryti

Receptor Information

Estimate Cover	Relative vegetative cover (high, medium, low, none) Mesa top: low (<20%); hillsides: medium (10–40%) Relative wetland cover (high, medium, low, none) Mesa top and hillsides: none (0%) Relative structures/asphalt cover (high, medium, low, none) Mesa top: medium (~20–30%); hillsides: none (0%)
Field Notes on the FIMAD Vegetation Class to Assist in Ground-Truthing the Arcview Information	The mesa top is developed but has some grasses (e.g., *Bouteloua* spp.) and sage (*Artemesia* spp.); the hillsides are piñon-juniper and ponderosa pine woodlands. Predominant tree and shrub species include ponderosa pine (*Pinus ponderosa*), piñon (*Pinus edulis*), one-seed juniper (*Juniperus monosperma*), Rocky Mountain juniper (*Juniperus scropulorum*), Gambel oak (*Quercus gambelii*), wavyleaf oak (*Quercus undulata*), mockorange (*Philadelphus microphyllus*), mountain mahogany (*Cercocarpus montanus*), New Mexico hops (*Ptelae trifoliata*), sumac (*Rhus* spp.), and sage. Predominant ground cover includes various grasses (e.g., *Bouteloua* spp.) and some forbs, as well as mosses and lichens in rocky areas.
Field Notes on T&E Habitat (if applicable) Consider the need for a site visit by a T&E subject matter expert to support the use of the site by T&E receptors.	The site visit confirmed that cliff-side areas are largely intact. However, these areas are close to the TA-54 operations, and T&E species may be impacted by noise, vibration, exhausts or fumes, erosion, and accelerated runoff from barren mesa-top areas. In general, the area is not ideal for T&E habitat because of site operations.
Are ecological receptors present at the site? (yes/no/uncertain) Describe the general types of receptors present at the site (terrestrial and aquatic) and make notes on the quality of habitat present at the site.	Yes. The mesa-top areas are managed in a way that limits ecological receptors to invasive plants, small mammals, birds, and invertebrates but may retain trophic integrity. The hillside areas appear to have intact biotic communities and therefore include a full suite of potential biotic receptors. Scoping activities revealed abundant invertebrates, reptiles, mammals, birds, and plant life on the hillsides.

Contaminant Transport Information

Surface Water Transport Field notes should summarize the erosion potential, including a discussion of the terminal point of surface water transport, if applicable.	Erosion potential of the mesa top is generally low to moderate because of the low gradient of most surfaces. However, sheet flow from rainstorm events has a high potential for runoff from the mesa top to the hillsides, thus fostering erosion of the hillsides. (There appear to be few best management practices (BMPs) on the mesa edge that limit the potential for water to organize into small rill-conduits that can further organize into larger flows [i.e., rivulets] on the hillside areas). The mesa top and edge and especially areas of the MDAs bordering the fence line are generally barren and have had much of the vegetation cut for fire control. This practice increases the potential for erosion from the mesa top and edge and the hillside. In the downslope areas, runoff clearly organizes itself into deeper and wider channels, until water reaches the canyon bottoms where potential energy is dissipated and water spreads across the canyon bottoms. Thicker deposits of erosive sediments typify downslope areas toward the surrounding canyon bottoms, where these sediments are widely distributed.
Are there any off-site transport pathways (surface water, air, or groundwater)? (yes/no/uncertain)	Yes. Surface water and air provide ample opportunity for transport of soil-borne contaminants off the mesa top and into the neighboring canyons.
Is an interim action (IA) needed to limit off-site transport? (yes/no/uncertain) Provide explanation/ recommendation for IA to project lead.	No IA is required to limit off-site transport. BMPs are in place to minimize erosion, and a new stormwater collection system was constructed at MDA G in 2000.

Ecological Effects Information

Physical Disturbance Provide list of major types of disturbances, including erosion and construction activities; review historical aerial photos where appropriate.	Much of the woodland areas that are typical of the hillsides show signs of erosion disturbance. In particular, the wooded areas bordering TA-54 on the northeastern and eastern edges of Mesita del Buey show signs of accelerated erosion from past conditions. In these areas, surface water movement accelerated by clearing the mesa-top vegetation and a fire break around MDA G has destroyed the biotic crust (cryptogamic crust) that is typical of wooded area soils of the Pajarito Plateau. Also, increasingly thicker deposits of erosive sediments typify downslope areas toward the surrounding canyon bottoms. In the canyon bottoms, erosional sediments are widely distributed. Such sediments (as well as the channelization of water) have negative effects on the understory flora and ground-dwelling fauna.
Are there obvious ecological effects? (yes/no/uncertain) Provide an explanation and apparent cause (e.g., contamination, physical disturbance, other).	The only obvious ecological effects from TA-54 operations are from physical disturbance of the area. There are no overt signs of contamination having ecological effects. Contaminants are known to have reached biotic populations, e.g., vegetation (Fresquez et al 1997, 62346), small mammals (Bennett et al. 1997, 62342), and invertebrates (Haarmann and Fresquez 1998, 62351); however, there have been no demonstrated population-wide or individual toxicological effects.

IA needed to limit apparent ecological effects? (yes/no/uncertain) Provide explanation and recommendations for IA to mitigate apparent exposure pathways to project lead.	No. Some contaminants may be entering the biota and are possibly being carried through the food chain (although there is no indication of effects from biomagnification). However, because there have been no measurable or observable effects on the biota, either to individuals or populations, an IA to ameliorate the current rate of transfer into the biota would be premature. Still, any actions that may decelerate the acquisition of contaminants by biotic organisms (e.g., the control of erosion) would be prudent for limiting exposure, thus limiting potential adverse effects associated with contaminant uptake or exposure.

No Exposure/Transport Pathways

If there are no complete exposure pathways to ecological receptors on site and no transport pathways to off-site receptors, the remainder of the checklist should not be completed. Stop here and provide additional explanation/justification for proposing an ecological no further action recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport.

There is the potential for some ground-dwelling organisms (e.g., fossorial rodents and deeply rooted plants) to intrude into buried waste. Additionally, future construction, grading, or digging activities pose the potential for mobilizing contaminants buried at depth, thus making them accessible to ecological receptors. At this time, soil-based contamination and volatile organic compound (VOC) vapors in rodent burrows pose the most significant threats to biota.

Adequacy of Site Characterization

Do existing or proposed data provide information on the nature, rate, and extent of contamination? (yes/no/uncertain) Provide explanation (consider if the maximum value was captured by existing sample data).	Existing data characterize the current conditions of contamination, including nature and distribution, at TA-54. However, current waste-handling operations are conducted in such a way that wastes added to the TA-54 inventory are projected to have zero availability to current ecological receptors; this includes new protocols for depth of burial (3 m) and containment as well as institutional controls.
Do existing or proposed data for the site address potential transport pathways of site contamination? (yes/no/uncertain) Provide explanation (consider if other sites should be aggregated to characterize potential ecological risk).	Yes. Existing data are adequate for characterizing models that describe the transport of soils and contaminants from the area of TA-54 to the far reaches of Cañada del Buey and Pajarito Canyon. Additional sampling is proposed to better define off-site transport and assist in modeling the site.

Additional Field Notes

Provide additional field notes on the site setting and potential ecological receptors.

In summary, the area of TA-54 is a controlled waste-handling operation that largely contains the waste inventory, thus limiting accessibility to ecological receptors. Legacy contamination that was released to the surface or near subsurface, however, may be reaching biotic receptors, primarily because of erosive forces exposing and mobilizing contaminants. To date, however, there are no apparent negative effects on the biota because of exposure to contamination. This state, however, may reflect a limitation of knowledge with regard to the reproductive, demographic, and genetic dynamics of receptor populations. Future potential for contaminant exposure (e.g., by mass-wasting events, biotic activity on the site) is only obviated by the large inventory of buried waste at TA-54. The availability of such wastes to biotic receptors will be dependent on the mechanism of exposure, rate of exposure, and the natural geochemical processes that preclude or foster biotic uptake.

Part C—Ecological Pathways Conceptual Exposure Model

Question A

Could soil contaminants reach receptors by way of vapors?

- *Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant >10-5 atm-me/mol and molecular weight <200 g/mol)*

Answer (likely/unlikely/uncertain): Likely

Provide explanation: VOCs at TA-54 are being measured for their flux off of the mesa.

MDA G. The primary VOC being emitted to the atmosphere is 1,1,1-trichloroethane (TCA). Next are perchloroethylene (PCE, tetrachloroethene), trichloroethylene (TCE, trichloroethene), and toluene.

MDA L. The primary VOCs being emitted to the atmosphere include TCA, TCE, and PCE. Secondary VOCs are Freon 113, acetone, and 1,1-dichloroethylene.

MDA H. There is no measurable VOC plume at this site. Tritium, although not a VOC, is known to be in flux from the ground to the atmosphere.

General. The effects of the VOCs and tritium on ecological receptors are poorly understood. Furthermore, the natural environmental processes that may cause exposure of VOCs to organisms are not well understood. For example, the amount of such vapors reaching receptors is dependent on atmospheric dispersion processes such as temperature, airborne moisture, wind speed and direction, connective dynamics, and atmospheric dilution. Confounding factors in the biota, such as anatomical and physiological characteristics and behavioral and reproductive phenologies, require direct experimental field observations in order to evaluate the degree of exposure to VOCs under natural conditions. Among all potential receptors, ground-dwelling organisms are probably the most vulnerable. In particular, ground-burrowing rodents will likely encounter vapors in the soil at higher concentrations than most other receptors. It is likely that the period of time when these animals are most vulnerable is when they are in burrows rearing young.

Question B

Could the soil contaminants reach receptors through fugitive dust carried in air?

- *Soil contamination would have to be on the actual surface of the soil to become available for dust.*
- *In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.*

Answer (likely/unlikely/uncertain): Likely

Provide explanation: Given current operations at TA-54 and erosional characteristics of the periphery of Mesita del Buey, there is a strong likelihood that fugitive dust will reach receptors in the area. The quantity of this exposure is not known and is a large uncertainty for evaluating ecological risk.

Question C

Can contaminated soil be transported to aquatic ecological communities? (use SOP 2.01, Rev. 0, "Surface Water Site Assessments," run-off score and terminal point of surface water runoff to help answer this question)?

- *If the SOP 2.01 runoff score* for each PRS included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway.*
  (Note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points).*
- *If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected by contamination from this site.*

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: There is some probability that water-borne constituents may reach aquatic communities at some time in the distant future. However, given the relatively flat terrain that surrounds the cliffs of Mesita del Buey, this does not appear to be a current exposure pathway to biota.

Question D

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

- *Known or suspected presence of contaminants in groundwater*
- *The potential for contaminants to migrate by way of groundwater and discharge into habitats and/or surface waters*
- *Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).*
- *Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.*

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Depth to groundwater from the top of Mesita del Buey is over 700 vertical feet. It is not probable that biota will ever be receptive of contaminants by way of a groundwater pathway.

Question E

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- *Suspected ability of contaminants to migrate to groundwater*
- *The potential for contaminants to migrate by way of groundwater and discharge into habitats and/or surface waters*
- *Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).*
- *Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.*

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: See response to Question D.

Question F

Might erosion or mass-wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- *This question is only applicable to release sites located on or near the mesa edge.*
- *Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.*

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Mass-wasting events are rare on an ecological time scale. (Many of the Anasazi Indian cliff dwellings in the area, each 800–1200 yr old, are still intact despite being in soft tuffaceous material at the edge of cliffs. Ecological time scales are measured by generation [a species-specific measure] and biogeographic changes in populations. The former are relatively short, 10–15 yr for a long-lived organism like an elk, while the latter are often multigenerational but often less than 1000 yr for even the longest-lived organisms, e.g., ponderosa pine. Thus, mass-wasting events of significant proportion occur on a frequency of less than what is observed for biogeographic changes in some of the longest-lived organisms.) There are no direct pathways for mass wasting into a surface water body.

Question G

Could airborne contaminants interact with receptors through respiration of vapors?

- *Contaminants must be present as volatiles in the air.*
- *Consider the importance of inhalation of vapors for burrowing animals.*
- *Foliar uptake of organic vapors is typically not a significant exposure pathway.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: See answer to Question A.

Question H

Could airborne contaminants interact with plants through deposition of particulates or with animals through inhalation of fugitive dust?

- *Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.*
- *Exposure by way of inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: See answer to Question B.

Question I

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- *Contaminants in bulk soil may partition into soil solution, making them available to roots.*
- *Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash)*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway).*

Terrestrial Plants: 3

Provide explanation: Root uptake is likely to have a large influence on the load of contaminants that are acquired by plants. Deeply rooted plants, such as junipers, may penetrate waste cells where capping soils are less than 3 m deep. Such deep rooted plants are not present within the fenced area of MDA H. Any contamination on the surface may reach plants by way of root uptake and/or rain splash.

Question J

Could contaminants interact with receptors through food web transport from surficial soils?

- *The chemicals may bioaccumulate in animals.*
- *Animals may ingest contaminated food items.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Animals: 2

Provide explanation: Uranium and TCE (known COPCs) are considered persistent bioaccumulators. No known bioaccumulators are COPCs at MDA H.

Question K

Could contaminants interact with receptors by way of incidental ingestion of surficial soils?

- *Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil, or while grooming themselves clean of soil.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Animals: 3

Provide explanation: The dietary fraction of surface soil in a receptor's diet is species specific. At TA-54, surface soil contamination is present, and fossorial animals will come into contact with subsurface contaminants that may then be transported to the surface during burrowing activities.

Question L

Could contaminants interact with receptors through dermal contact with surficial soils?

- *Significant exposure by way of dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 2

Provide explanation: Because there are contaminants in the surface soils at TA-54, terrestrial animals will make some dermal contact. However, this is a far less important pathway than dietary uptake, as the pelage of mammals, the scales of reptiles, the exoskeletons/exoderms of invertebrates, and the feathers of birds offer substantial protection from dust and water penetration to the skin.

Question M

Could contaminants interact with plants or animals through external irradiation?

- *External irradiation effects are most relevant for gamma-emitting radionuclides.*
- *Burial of contamination attenuates radiological exposure.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Plants: 3

Terrestrial Animals: 3

Provide explanation: Depending on the level of radiological contamination, this pathway may be a major. At TA-54, known radiological COPCs include plutonium-239, americium-241, and tritium. Tritium is the only radionuclide contaminant at MDA H and is confined to the subsurface.

Question N

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- *Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.*
- *Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.*
- *Contaminants in sediment may partition into soil solution, making them available to roots.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway).

Terrestrial Plants: 0

Provide explanation: There are no aquatic environs on TA-54.

Question O

Could contaminants interact with receptors through food web transport from water and sediment?

- *The chemicals may bioconcentrate in food items.*
- *Animals may ingest contaminated food items.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = major pathway):

Terrestrial Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question P

Could contaminants interact with receptors by way of ingestion of water and suspended sediments?

- *If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.*
- *Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway).*

Terrestrial Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question Q

Could contaminants interact with receptors through dermal contact with water and sediment?

- *If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.*
- *Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 =*major pathway):*

Terrestrial Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question R

Could contaminants interact with plants or animals through external irradiation?

- *External irradiation effects are most relevant for gamma-emitting radionuclides.*
- *Burial of contamination attenuates radiological exposure.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway):*

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question S

Could contaminants bioconcentrate in free-floating aquatic plants, attached aquatic plants, or emergent vegetation?

- *Aquatic plants are in direct contact with water.*
- *Contaminants in sediment may partition into pore water, making them available to submerged roots.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway).*

Aquatic Plants/Emergent Vegetation: 0

Provide explanation: There are no aquatic environs on TA-54.

Question T

Could contaminants bioconcentrate in sedimentary or water column organisms?

- *Aquatic receptors may actively or incidentally ingest sediment while foraging.*
- *Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.*
- *Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway):*

Aquatic Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question U

Could contaminants bioaccumulate in sedimentary or water column organisms?

- *Lipophilic organic contaminants and some metals may concentrate in an organism's tissues.*
- *Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.*

Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = minor pathway, 3 = *major pathway).*

Aquatic Animals: 0

Provide explanation: There are no aquatic environs on TA-54.

Question V

Could contaminants interact with aquatic plants or animals through external irradiation?

- *External irradiation effects are most relevant for gamma-emitting radionuclides.*
- *The water column acts to absorb radiation, thus external irradiation is typically more important for sediment-dwelling organisms.*

*Provide quantification of exposure pathway (0 = no pathway, 1 = unlikely pathway, 2 = min*or pathway, 3 = *major pathway):*

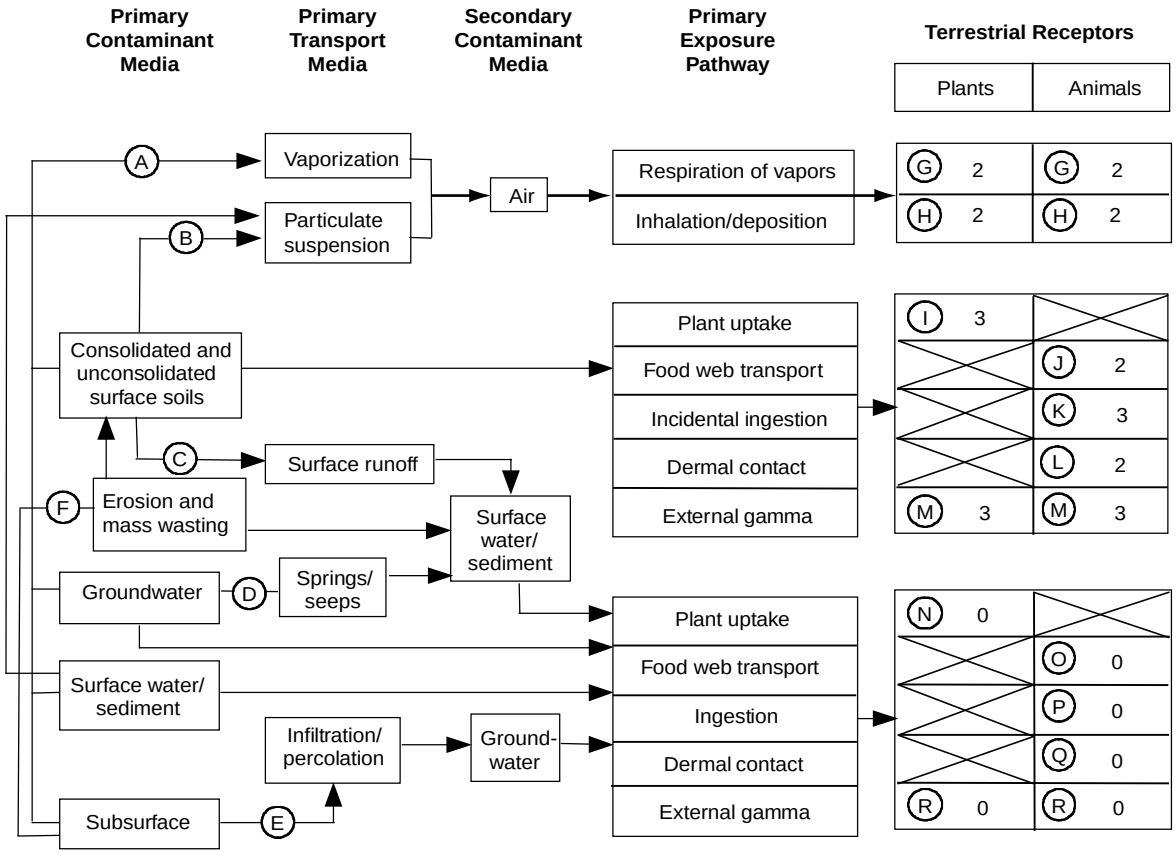
Aquatic Plants: 0

Aquatic Animals: 0

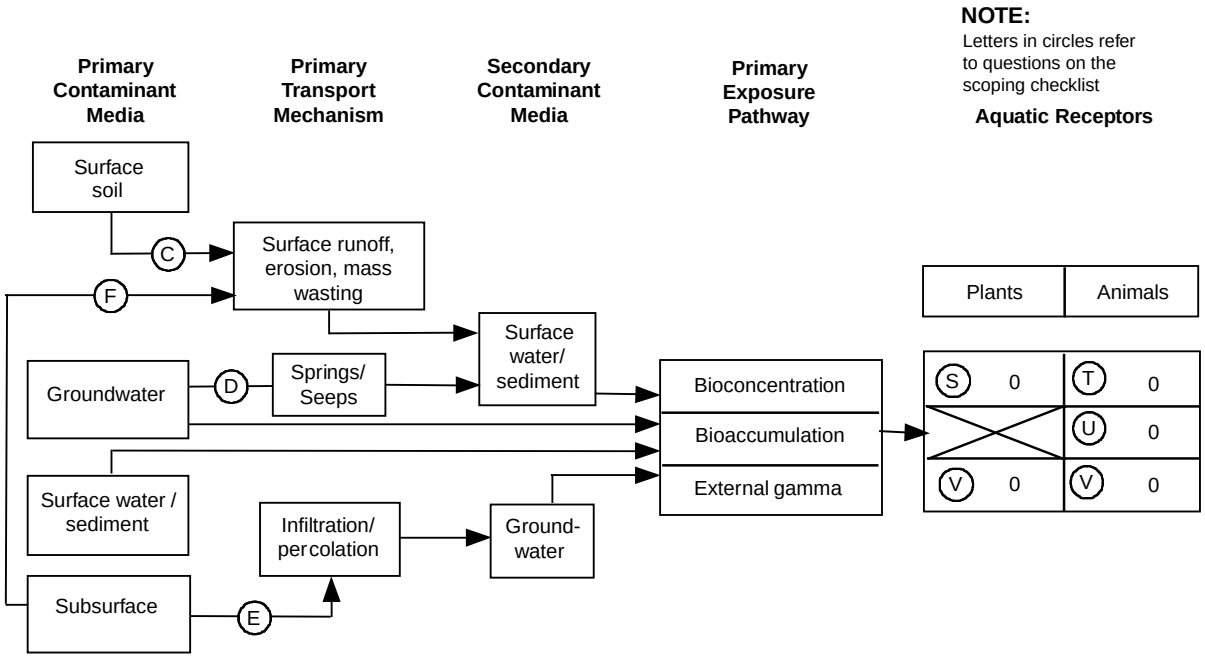
Provide explanation: There are no aquatic environs on TA-54.

Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model



Signatures and certifications

Checklist completed by

Name (printed):	Mark M. Hooten
Name (signature):	
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Date completed: Final draft: July 1, 1999.

Verification:

Name (printed):	Richard Mirenda
Name (signature):	
Organization:	EES-13, Environmental Restoration (ER) Project
Phone number:	(505) 665-6953

One of the most important products of the TA-54 scoping checklist is the narrowed focus on terrestrial receptors. Receptors for the ecological screening assessment were chosen to be broadly representative of organisms found in a functional food chain in the greater Los Alamos area. Associations of the functional trophic structure of terrestrial flora and fauna are presented in Figure F-2.0-1. This functional structure forms the basis for the choice of screening-level ecological receptors for the screening assessment. Eight terrestrial receptors cover eleven trophic categories. These include a generic plant; a soil-dwelling invertebrate (an earthworm); an American robin (avian invertebrate eater, avian omnivore, and avian herbivore); an American kestrel (avian invertebrate/flesh eater, avian flesh eater); a deer mouse (mammalian omnivore); a vagrant shrew (mammalian invertebrate eater); a desert cottontail (mammalian herbivore); and a gray fox (mammalian flesh eater).

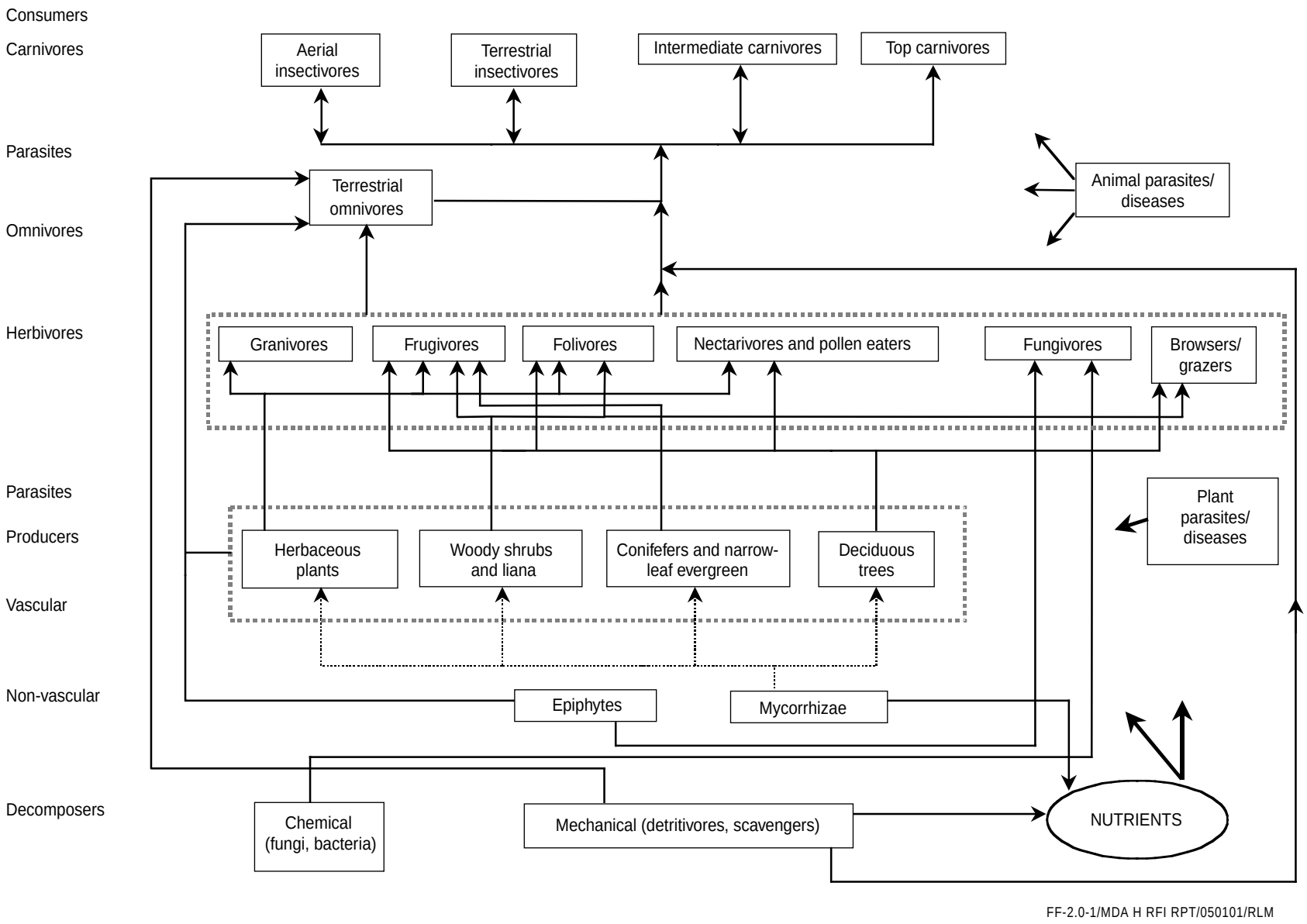

Figure F-2.0-1. Terrestrial functional food chain for TA-54 and Los Alamos at large

F-3.0 REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER record identification (ER ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 54."

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the Department of Energy Los Alamos Area Office; United States Environmental Protection Agency, Region 6; and the ER Project MDAs Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

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Bennett, K., J. Biggs, and P. Fresquez, January 1997. "Radionuclide Contaminant Analysis of Small Mammals at Area G, TA-54, Los Alamos National Laboratory, 199," Los Alamos National Laboratory report LA-13242-MS, Los Alamos, New Mexico. (Bennett et al. 1997, 62342)

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EPA (U.S. Environmental Protection Agency), August 1997. "Exposure Factors Handbook," Volume I: General Factors, National Center for Environmental Assessment, Office of Research and Development, (EPA/600/P-95/002Fa), Washington D.C. (EPA 1997, 66596)

Environmental Surveillance Program, September 1998. "Environmental Surveillance at Los Alamos During 1994," Los Alamos National Laboratory Report LA-13487-ENV, Los Alamos, New Mexico. (Environmental Surveillance Program 1998, 59904)

Fresquez, P., E. Vold, and L. Naranjo, Jr., July 1997. "Radionuclide Concentrations in Soils and Vegetation at Radioactive-Waste Disposal Area G during the 1996 Growing Season," Los Alamos National Laboratory report LA-13332-PR, Los Alamos, New Mexico. (Fresquez et al. 1997, 62346)

Haarman, T., and P. Fresquez, July 1998. "Radionuclide Concentrations in Honey Bees from Area G at TA-54 during 1997," Los Alamos National Laboratory report LA-13480-PR, Los Alamos, New Mexico. (Haarmann and Fresquez 1998, 62351)

Appendix G

Relevant Documents

APPENDIX G RELEVANT DOCUMENTS

G-1.0 DOCUMENTATION OF REGULATORY HISTORY

G-1.1 Corrective Action History

The following is a summary of the corrective action history for Potential Release Site (PRS) 54-004, Material Disposal Area (MDA) H, at Technical Area (TA) 54. It includes notices of deficiencies (NODs) and/or determination, responses to NODs, modifications to Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) documents, other administrative authority actions, and each Los Alamos National Laboratory (the Laboratory) response. Table G-1 includes a description, regulatory status, and corrective action summary.

Table G-1
Documentation of Regulatory Status/Corrective Action History for MDA H

Unit Type and Description	PRS Number	HSWA[a] PRSs (Y/N)	Permitted Waste Management Areas (Y/N)	Regulatory Status	Corrective Action History	Other Regulatory Documents
MDA H (except shaft 9) shafts 1–8 active before 11/19/88	54-004	Y	Shaft 9 only	Approved RFI work plan for OU[b] 1148 implemented, results reported herein	• Submitted OU 1148 RFI work plan to EPA[c], May 1992. • Received NOD from EPA, 11/30/92. • Submitted NOD response to EPA, 11/12/93. • EPA approved OU 1148 work plan, 12/14/93. • EM/ER [d] notifies DOE[e] Los Alamos Area Office of subsurface sampling schedule, 4/18/95. • RFI of MDA H begins June 1995.	n/a[f]

[a] HSWA = Hazardous and Solid Waste Amendment.

[b] OU = operable unit.

[c] EPA = Environmental Protection Agency.

[d] EM = environmental management, ER = environmental restoration.

[e] DOE = Department of Energy.

[f] n/a = not applicable.

The "RFI Work Plan for Operable Unit 1148" (LANL 1992, 7669) was submitted to EPA in May 1992. The work plan addressed the RFI investigation of 38 PRSs at TA-54. The PRSs are organized within four MDAs: G, H, J, and L. The preliminary or initial administrative authority actions and the Laboratory responses relate to all four MDAs at TA-54. Administrative authority actions and Laboratory responses that were directed at specific MDAs are identified below.

1. *November 30, 1992*. EPA issued an NOD for the RFI work plan OU 1148 (Driscoll 1992, 3849.3).
2. *August 25, 1993*. Revised Appendix A, the pilot extraction study plan, for the RFI work plan for OU 1148 was approved by EPA (Honker 1993, 30522).
3. *November 12, 1993*. The Laboratory responds to the NOD for the OU 1148 RFI work plan (Glatzmaier 1993, 30987).

4. *November 15, 1993*. Technical comment memorandum from the New Mexico Environment Department (NMED) for RFI work plan OU 1148 was forwarded to the Laboratory (Swanton 1993, 63981).
5. *December 14, 199*3. The RFI work plan for OU 1148 was approved by the EPA (Davis 1993, 38812).
6. *March 28, 1995*. A request for permit modification units proposed for no further action (NFA) was submitted to NMED and EPA (LANL 1995, 45365).
7. *October 11, 1995*. The DOE concurs with the determination of NFA for non-HSWA units included in the March 1995 permit modification request (Taylor 1995, 50023).
8. *December 10, 1996*. NMED forwards the notice of determination on request for permit modification units proposed for NFA (Dinwiddie 1996, 55815).
9. *February 27, 1996*. The report, "RFI Report for Channels Sediment Pathways from MDAs G, H, J, and L, TA-54," was submitted to EPA (Jansen and Taylor 1996, 54462.1).
10. *September 23, 1997*. The report, "RFI Report for Channel Sediment Pathways from MDAs G, H, J, and L, TA-54" was approved by NMED (Dinwiddie 1997, 63982).
11. *October 21, 1998*. NMED proposes to approve NFA for 99 solid waste management units at the Laboratory (Kelley 1998, 62357).
12. *December 23, 1998*. NMED approves the Class III permit modification to remove 99 solid waste management units from the DOE/Laboratory RCRA permit (Kelley 1998, 63042).

G-1.2 Other Regulatory Documents

The following is a summary of other applicable administrative authority documents that are not covered in Section G-1.1 above. This primarily includes, but is not limited to, correspondence regarding modifications to sampling plans. Proposed Laboratory modifications initially relate to all four MDAs at TA-54. Subsequent administrative authority responses and Laboratory proposals/responses that were directed at specific MDAs are identified below.

1. *October 19, 1993.* Proposed modifications to the RFI work plan for OU 1148 were discussed during a conference call between Laboratory OU 1148 personnel and EPA (Barbara Driscoll). This conference call is referred to in the June 8, 1994, memorandum (Item 3).
2. *April 8, 1994*. A conference call took place between Laboratory OU 1148 personnel and EPA. The notes of the call documented proposed modifications to the RFI work plan for OU 1148 (MDA H not affected). The call was documented in notes (April 21, 1994) by Glatzmaier (1994, 35207).
3. *June 8, 1994*. A letter was sent from T. Glatzmaier (EM/ER) to T. Taylor (DOE). The letter included the proposed modifications to the RFI work plan for OU 1148 and a draft cover letter for Mr. Taylor to submit to Barbara Driscoll (MDA H not affected) (Glatzmaier 1994, 52015).
4. *July 15, 1994*. Proposed modifications to the RFI work plan for OU 1148 and cover letter from Tracy Glatzmaier were retransmitted to Mr. Taylor.

REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER record identification (ER ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of

the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 54."

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the DOE Los Alamos Area Office; United States EPA, Region VI; and the ER Project Material Disposal Areas Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

Davis, A., December 14, 1993. "RFI Work Plan for OU 1148, Approval Los Alamos National Laboratory NM0890010515," Environmental Protection Agency memorandum to J. Vozella, Dallas, Texas. (Davis 1993, 38812)

Dinwiddie, R., December 10, 1996. "Notice of Determination Requests for Permit Modification Units Proposed for No Further Action March and September 1995," New Mexico Environment Department memorandum to T. Taylor and J. Jansen, Santa Fe, New Mexico. (Dinwiddie 1996, 55815)

Dinwiddie, R., September 23, 1997. "Approval of RCRA Facility Investigation (RFI) Report for Channel Sediment Pathways from Material Disposal Areas (MDAs) G, H, J, and L at Technical Area (TA) 54, Los Alamos National Laboratory NM0890010515," New Mexico Environment Department memorandum to G. Todd and S. Hecker, Santa Fe, New Mexico. (Dinwiddie 1997, 63982)

Driscoll, B., November 30, 1992. "Overall Comments," Environmental Protection Agency informal memorandum to C. Rofer. (Driscoll 1992, 3849.3)

Glatzmaier, T., November 12, 1993. "Final Notice of Deficiency (NOD) Response for Operable Unit (OU) 1148," Los Alamos National Laboratory memorandum EM-13:93-A232, Los Alamos, New Mexico. (Glatzmaier 1993, 30987)

Glatzmaier, T., April 21, 1994. "Summary of Conference Call with Barbara Driscoll, Environmental Protection Agency (EPA), Region 6," Los Alamos National Laboratory memorandum EM/ER:94-A153, Los Alamos, New Mexico. (Glatzmaier 1994, 35207)

Glatzmaier, T., June 8, 1994. "Proposed Modification to the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1148," Los Alamos National Laboratory memorandum EM/ER:94-A199, Los Alamos, New Mexico. (Glatzmaier 1994, 52015)

Honker, W., August 25, 1993. "Pilot Extraction Study Plan for the Organic Vapor Plume Los Alamos National Laboratory NM0890010515," Environmental Protection Agency memorandum to J. Vozella, Dallas, Texas. (Honker 1993, 30522)

Jansen, J., and T. Taylor, February 27, 1996. "Submittal of the Resource Conservation and Recovery Act Facility Investigation (RFI) Report for Channels from Material Disposal Areas (MDAs) G, H, J, and L) in Technical Area (TA) 54," Los Alamos National Laboratory memorandum EM/ER:96-077 to D. Neleigh, Los Alamos, New Mexico. (Jansen and Taylor 1996, 54462.1)

Kelley, E., October 21, 1998. "Proposal to Approve: No Further Action for 99 Solid Waste Management Units (SWMUs) at Los Alamos National Laboratory (LANL)," New Mexico Environment Department memorandum to D. Gurule and J. Browne, Santa Fe, New Mexico. (Kelley 1998, 62357)

Kelley, E., December 23, 1998. "Approval: Class III Permit Modification to Remove Ninety-Nine (99) Solid Waste Management Units from the Department of Energy/Los Alamos National Laboratory RCRA permit NM 0890010515," New Mexico Environment Department memorandum to T. Taylor and J. Browne, Santa Fe, New Mexico. (Kelley 1998, 63042)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1148," Los Alamos National Laboratory report LA-UR-92-855, Los Alamos, New Mexico. (LANL 1992, 7669)

LANL (Los Alamos National Laboratory), March 1995. "Request for Permit Modification, Units Proposed for NFA," Los Alamos National Laboratory report LA-UR-95-767, Los Alamos, New Mexico. (LANL 1995, 45365)

Swanton, B., November 15, 1993. “Review of LANL’s May 1992 RCRA Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1148,” New Mexico Environment Department memorandum to D. Webb, Santa Fe, New Mexico. (Swanton 1993, 63981)

Taylor, T., October 11, 1995. “NFA Permit Modification,” Department of Energy memorandum to H. Jansen, Los Alamos, New Mexico. (Taylor 1995, 50023)